

THE APPLICATION OF SODIUM FLUOSILICATE BY AIRPLANE IN AN ATTEMPT TO CONTROL THE SUGAR-CANE MOTH BORER

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INTRODUCTION

One of the limiting factors in the production of sugar cane in the Southern States is the damage caused by the sugar-cane moth borer,² resulting in an average loss estimated at about 20 per cent of the sugar. By destroying the young plants and by tunneling through the large stalks the borer reduces both the tonnage and the sucrose content and facilitates the entrance of diseases, which in turn further reduce the yield.³

After an announcement made by the Louisiana State Experiment Station in 1925 that dusting the sugar cane with sodium fluosilicate would kill borers, the writers⁴ conducted a preliminary experiment with this chemical, obtaining apparently no kill, but, on the other hand, causing some burning of the dusted cane. Results obtained at the Louisiana station,⁵ however, in an experiment in dusting cane with sodium fluosilicate from an airplane appeared to be satisfactory. The Bureau of Entomology planned, therefore, to conduct a similar dusting experiment in 1927, using the most promising brand of dust, and the airplane as the machine for application.

Early in July, 1927, Louisiana interests appealed to the United States Department of Agriculture for \$50,000, to be expended in

¹G. W. Bamberg, D. D. Ewing, jr., H. S. Hollingsworth, L. A. Mayer, and H. T. Woodruff, temporary employees of the Bureau of Entomology, deserve credit for notes on the effect of the poison on the moth borer.

²*Diatraea saccharalis* Fab.

³To discover an effective control for the moth borer, the United States Department of Agriculture has conducted many experiments; and among its findings is the fact that the seed cane may be completely cleared of infestation by soaking it in either hot or cold water. Such treatments, if generally adopted in connection with certain cultural recommendations, would go far in controlling the pest. See YODER, P. A., and INGRAM, J. W. HOT-WATER TREATMENT OF SUGAR CANE FOR INSECT PESTS—A PRECAUTION. U. S. Dept. Agr., Dept. Circ. 303, 4 p. 1923; YODER, P. A. HOT-WATER TREATMENT OF DORMANT AND SPROUTED SEED CANE. U. S. Dept. Agr., Dept. Circ. 337, 4 p. 1925; also HOLLOWAY, T. E., HALEY, W. E., and LOFTIN, U. C. THE SUGAR-CANE MOTH BORER IN THE UNITED STATES. U. S. Dept. Agr. Tech. Bul. 41, 77 p., illus. 1928.

⁴HOLLOWAY, T. E., HALEY, W. E., and INGRAM, J. W. EXPERIMENTS IN POISONING THE CANE BORER WITH SODIUM FLUOSILICATE. Planter and Sugar Manfr. 77: 431. 1926. (Also published in Sugar Bull. 5 (5): 4-5, 1926; Facts About Sugar 21: 1142, 1926.)

⁵HINDS, W. E., and SPENCER, H. AIRPLANE DUSTING FOR SUGAR-CANE BORER CONTROL IN LOUISIANA. Jour. Econ. Ent. 20: 352-358, 1927.

dusting 5,000 acres of the new disease-resistant P. O. J. varieties of cane to protect it from the ravages of the borer and insure the maximum quantity of sound seed cane for planting in the recently flooded areas. The possibility of negative results and of damage to the dusted cane was fully realized. It was felt, however, that the good which might be accomplished, should the experiment prove successful, would be so great and so far-reaching as to justify the extension of the original experiment to include the dusting of the 5,000 acres of seed cane, and this was accordingly done. The acreage of the new varieties, which are expected to rehabilitate the Louisiana sugar industry, was limited, and no measure other than dusting was known which could be applied to protect the valuable cane from the moth borer at that season of the year.

The allotment of fields to be dusted was undertaken by the Office of Sugar-Plant Investigations of the Bureau of Plant Industry, and F. D. Stevens, of that office, was made responsible for locating the fields and allotting acreages to be dusted. Sugar planters were to make application to the United States Department of Agriculture to have their fields dusted.

The selection of the fields was very laborious and necessitated considerable travel over the sugar-producing parishes. It was necessary to find suitable landing fields for the airplanes, to draw maps of the fields to be dusted, and to mark the fields themselves with signal flags for the flyers. If the acreage to be dusted had been concentrated in a single locality, the work of applying dust would have been a very simple task; but, in order to benefit the Mississippi flood sufferers, fields located all the way from above New Roads to Lockport and thence to Lafayette, La., were selected, along a stretch of at least 200 miles. It was required that the cane in dusted fields be used for seed, that it be of the new P. O. J. varieties, and that the seed cane be made available to flood sufferers. The cane was dusted three times, at monthly intervals beginning August 1, about 16 pounds of sodium fluosilicate dust being used per acre at each application. Two brands of dust were used. One of these was the most promising American kind, and the other a highly recommended imported brand. Owing to the fact that but little time was available, the problem of dusting 5,000 acres of sugar cane, divided into rather small fields and scattered over a distance of 200 miles, was difficult. Under these circumstances the successful application of the dust was made possible by the whole-hearted cooperation on the part of every one interested in the work, including the contractor and most of the sugar planters. Some time was lost by the delay in delivery of the poison, by the caking of some of the imported dust, owing to dampness accumulated on the way, and by the fact that, after the first application, some of the planters requested that the dusting be discontinued on account of resultant burning of the leaves of the sugar cane. In such cases the poison already received at a given point had to be reshipped to other plantations where additional acreage was to be dusted. Reshipment was made by the contractor without charge.

SELECTION OF FIELDS

To determine the results of the experiment two kinds of observations were made. It was desirable to know the effect of the poison

on the borers themselves, and the effect on the rate of infestation in the cane. The rate of mortality of borers in the cane was obtained by cutting open samples of the cane after each dusting and counting every live and every dead borer found. The effect on the rate of infestation was more difficult to learn. At the beginning of the experiment, at a given place, a dusted field and, for check purposes, one not dusted were selected, both having as nearly as possible the same intensity of borer infestation, and in all cases, of course, the two fields were of the same variety of cane. The fields had to be neighboring, so as to make a comparison possible, and it was necessary to examine many fields in order to obtain two having about the same infestation. These special experimental pairs of fields were located at various places in the dusted sections. At the end of the experiment they were again carefully examined and the results compared with the figures obtained before the first application of dust.

EFFECT OF DUST ON THE MOTH BORER

After each application of the chemical, sugar-cane stalks were carefully cut open and all dead and living borers contained in them were counted. The examinations were made in the period extending from the fourth to the fifteenth day after dusting, but more than two-thirds of them were made, and more than two-thirds of the dead larvae were found, in the interval from the fifth to the eighth day, inclusive. In all, 7,382 stalks were thus examined, and 7,574 borers were found, of all larval stages and the pupal stage. The borers found inside and outside the stalks were counted separately. A numerical analysis of these counts is presented in Table 1, which indicates that the maximum percentage of mortality was observed on the ninth day after the dust was applied, this figure being 28.9 per cent, though on the sixth day almost as high a percentage was reached. As many more borers were included in the counts for the sixth day, however, it is probable that the figure for that day, 28.2 per cent, is more nearly correct as indicating the time between dusting and maximum mortality.

TABLE 1.—Results of examinations of sugar-cane stalks after dusting and of stalks not dusted, showing live and dead larvae and pupae of the sugar-cane moth borer

Treatment	Interval between dusting and examination	Fields examined	Stalks examined	Larvae and pupae—								
				Inside the stalk			Outside the stalk			Total		
				Alive		Dead	Alive		Dead	Alive		Dead
	Days	No.	No.	No.	No.	P. ct.	No.	No.	P. ct.	No.	No.	P. ct.
Dusted.....	4	9	775	316	34	9.7	132	122	48.0	448	156	25.8
Do.....	5	15	1,295	903	65	6.7	316	291	47.9	1,219	356	22.6
Do.....	6	19	1,650	788	98	11.1	324	338	51.1	1,112	436	28.2
Do.....	7	20	1,337	733	66	8.3	235	233	49.8	968	299	23.6
Do.....	8	8	675	802	36	4.3	167	98	37.0	969	134	12.1
Do.....	9	3	275	88	11	11.1	67	52	43.7	155	63	28.9
Do.....	10	4	475	188	24	11.3	56	34	37.8	244	58	19.2
Do.....	11	1	200	65	6	8.5	23	22	48.9	88	28	24.1
Do.....	12	2	300	107	6	5.3	54	45	45.5	161	51	24.1
Do.....	13	1	200	151	9	5.6	70	53	43.1	221	62	21.9
Do.....	15	1	200	148	6	3.9	111	81	42.2	259	87	25.1
Check (not dusted).....	-----	26	2,483	1,105	39	3.4	409	103	20.1	1,514	142	8.6

Of these data a more detailed analysis, not brought out in Table 1, shows that most of the mortality observed was among the small larvae outside the stalks, the maximum percentage of this being 61. After the larvae have entered the stalks they are comparatively safe, and their safety increases as they reach maturity. Among the large larvae found inside the stalks there was a total mortality of less than 10 per cent; and among the pupae, which are rarely found outside the stalks, the mortality was still lower. When the natural mortality of the sugar-cane moth borer, as observed in this experiment, is considered, it becomes evident that the actual kill due to the poison was even less than is indicated by the preceding statement. In connection with the examinations made in dusted sugar cane, the inspectors examined 2,483 stalks of sugar cane which had not been dusted, and found 1,656 larvae and pupae, some of the details concerning which are shown in the last line of Table 1. It was found that 8.6 per cent of all stages had died, and that the natural percentage of mortality among the small larvae outside the stalk was 25.4.

It appears that for all stages the actual percentage of mortality due to the dust would be 28.2 minus 8.6, or 19.6, while for the small larvae outside the stalks the maximum percentage would be 61 minus 25.4, or 35.6.

BORER INFESTATION OF SUGAR CANE

The real test of the dusting is whether the degree of infestation in the sugar cane was reduced. The sugar planter is naturally interested in reports of the kill, but, after all, he requires sugar cane and not dead borers for the manufacture of sugar. Accordingly, experiments were undertaken to determine the effect of dusting on the degree of infestation.

Fifteen experiments were started, there being for each experiment a check field and a field to be dusted; but at Shadyside, St. Mary's Parish, the check field was dusted by mistake, and at Cinclare, West Baton Rouge Parish, both the dusted field and the check field were cut early in October, before the final examination was made. There remained 13 pairs of experimental fields, located at a number of places in the sugar-producing parishes, the dusted fields of 2 of which received one, those of 2 three, and those of the remaining 9 two applications each of poison. Because of burning produced by the poison, only one application was made at Glynn and at Smithfield, and, by previous arrangement, only two were made at Southdown. In several other cases the final examinations were made before the third dusting occurred, because the cane might be cut. The results in all these cases are presented in Table 2.

TABLE 2.—*Borer infestation in sugar cane dusted by airplane with sodium fluosilicate and in cane not dusted*

Location of field		Treatment of field		Condition of field before treatment		Condition of field after treatment		Increase in stalk infestation
Parish	Plantation			Date of examination	Stalks bored	Date of examination	Stalks bored	
					Per cent		Number	Per cent
West. Baton Rouge.	Smithfield	Dusted Aug. 13.	Check	Aug. 11	61.0	Oct. 5	94.5	35.5
Do	do	Check	Check	do	55.6	do	98.6	43.0
Pointe Coupee.	Glynn	Dusted Aug. 14.	Check	Aug. 12	27.8	do	95.3	67.8
Do	do	Check	Check	do	29.0	do	89.0	60.0
Terrebonne.	Southdown	Dusted Aug. 2 and Sept. 24.	Check	Aug. 2	31.0	Oct. 6	96.6	65.6
Do	do	Check	Check	do	64.0	do	94.5	30.5
Do	do	Dusted Aug. 3 and Sept. 24.	Check	Aug. 3	17.0	do	90.3	73.3
Do	do	Check	Check	do	18.6	do	89.0	70.4
Do	do	Dusted Aug. 2 and Sept. 24.	Check	Aug. 3	19.3	Oct. 7	99.0	79.7
Do	do	Check	Check	do	21.5	do	96.5	75.0
La Fourche.	Raceland	Dusted Aug. 5 and Sept. 23.	Check	do	34.0	Oct. 20	87.0	53.0
Do	do	Check	Check	do	44.0	do	95.0	51.0
Assumption.	Westfield	Dusted Aug. 20 and Sept. 18.	Check	Aug. 15	65.0	Oct. 12	91.5	26.5
Do	do	Check	Check	do	67.0	do	92.5	25.5
Do	Elmfield	Dusted Aug. 20 and Sept. 18.	Check	Aug. 16	51.5	do	62.5	11.0
Do	do	Check	Check	do	48.5	do	61.5	13.0
St. Mary.	Alice C.	Dusted Aug. 27-28 and Sept. 26.	Check	Aug. 26	23.0	Oct. 13	40.3	17.3
Do	do	Check	Check	do	35.0	do	54.3	22.0
Iberia.	Leon Landry	Dusted Aug. 24 and Oct. 1.	Check	Aug. 23	66.5	do	90.5	19.5
Do	do	Check	Check	do	61.3	do	94.0	24.0
Lafayette.	P. R. Landry	Dusted Aug. 25 and Sept. 29.	Check	Aug. 24	62.6	do	78.0	32.7
Do	do	Check	Check	do	59.0	do	72.5	15.4
Iberville.	St. Louis	Dusted Aug. 11, Sept. 27, and Oct. 14.	Check	Aug. 10	30.5	Oct. 28	77.0	13.5
Do	do	Check	Check	do	30.0	do	89.0	46.5
Do	Catherine.	Dusted Aug. 9, Sept. 12, and Oct. 14.	Check	Aug. 9	59.5	do	98.0	59.0
Do	do	Check	Check	do	65.5	do	100.0	38.5
Do	do	Check	Check	do	65.5	do	100.0	34.5

Table 2 indicates that the advantage of the kill previously recorded was offset by the extraordinary fecundity of the insect. Though on as many as three occasions, at intervals of about one month, nearly one-fifth of the larvae and pupae were killed, the reproductive power of the species was apparently sufficient to compensate for this mortality. Also, though about one-fifth of the larvae and pupae in a given field were dead at one time, it is to be remembered that the moths and eggs were unaffected. New moths emerged from the many pupae which had been left undisturbed, and oviposition went on as usual.

The degree of infestation, measured by the proportion of stalks bored, will be seen to have risen from comparatively low percentages, approximately at the beginning of the experiments, to as high as 100 per cent of the stalks examined. In other cases it did not rise so high, but it is remarkable that in every case except one the infestation in the dusted field is rather uniform with that of the check field, as if the application of sodium fluosilicate had produced no effect whatever.

The one exception was the experiment at St. Louis Plantation, where the infestation of the dusted field more than doubled, but still remained 12 per cent below the final figure for the check field. This is so unusual that the writers believe it may be due to some factor other than the dust, probably to the activity of the egg parasite *Trichogramma minutum* Riley. As the infestation of the dusted field at St. Louis Plantation was 77 per cent, however, the borer was not controlled even there.

By selecting special cases, as that of Alice C. Plantation, where the final infestations observed were 40.3 per cent for the dusted field and 54.5 per cent for the check field, it may seem that there was a decrease due to dusting, but by comparing the infestations existing before dusting it appears that the dusted field had at the outset a much lower infestation than the check. By way of contrast, Glynn Plantation affords an instance in which the dusted and the check fields were within 2 per cent of each other at the beginning, but a little more than 6 per cent apart at the end, the dusted field, lower at the beginning, having a greater infestation at the end.

Analysis of the last column of Table 2 indicates that eight times out of thirteen the increase in infestation in the dusted fields was greater than the increase in the check fields.

The percentage of stalks infested is something easily understood, but in estimating infestation of the joints the use of percentages has been avoided. As the numbers of joints on the different stalks of sugar cane vary, an average of two joints infested per stalk would amount to a given percentage in one field and to a different percentage in another. As an indication of intensity, the writers have preferred to give the average number of bored joints per bored stalk, as estimated by an observer of long experience.

BURNING OF THE PLANTS

After the first application of the domestic brand of dust on the estate of H. C. Minor, the writers received a letter from the owners requesting that, because of excessive burning, no more of this brand be used. After one application of the foreign brand of

sodium fluosilicate had been made, Milliken & Farwell requested that dusting cease on all their plantations. An experiment-station official having years of experience in sugar-cane culture estimated a loss of 1 ton per acre, while a plantation manager estimated a loss of from 1 ton to $2\frac{1}{2}$ tons per acre as a result of burning by sodium fluosilicate.

COST OF THE APPLICATIONS

The cost of materials and their application by airplane was about \$7.80 per acre.

SUMMARY

Five thousand acres of the new P. O. J. varieties of sugar cane were dusted by airplane from one to three times with two different brands of sodium fluosilicate, in an attempt to protect the crop from the ravages of the sugar-cane moth borer.

An apparent death rate of 28.2 per cent of borers was observed, mostly among small ones, but this was partly offset by the natural mortality of 8.6 per cent, giving as a result of the poison a net kill of 19.6 per cent.

Thirteen experiments, conducted at various places, failed to indicate control. This failure is believed to be accounted for by the low per cent of kill and the high rate of reproduction of the moth borer.

The sugar cane was injured by the application of sodium fluosilicate, and estimates made by experienced men indicate that the injury was serious.

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